The development and refinement of the air-root-pruning container was conducted by Dr. Carl Whitcomb and his students (2,3). The objective of this research was to grow a tree seedling that maximized growth in the shortest possible time. These milk-carton seedlings were potted to larger containers to realize the potential of super seedlings.

This system of potting milk-carton-grown seedlings to larger containers takes maximum advantage of the potential of milk-carton-grown seedlings. Not until more container growers evaluate this system of production and achieve salable sizes in much less time than with bare-root seedlings, will the milk carton container reach its potential.

LITERATURE CITED

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TREES FROM CUTTINGS VS. THOSE FROM SEEDLINGS

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Much research has been conducted in recent years in an effort to obtain accelerated growth from plants. Some of the work has centered upon the development of a better root system through the utilization of different hormone combinations. Other research has focused upon the development of containers that encourage well-branched root systems without spiraling.

From my experience in the production of trees using both cuttings and seeds, I believe that accelerated growth can best be obtained by giving special attention to the development of a well-branched fibrous root system and to the timely shifting up of the liner. At Simpson Nurseries we grow trees from bareroot liners, seed, softwood cuttings, hardwood cuttings, and from buds and grafts. However, the softwood production of trees compared to seedling production in bottomless containers is emphasized in the following information.

TREE SEEDLING PRODUCTION IN BOTTOMLESS POTS

We grow 16 different cultivars of trees in our bottomless pot liner production. Production begins with direct seeding in 2¼ × 2¼ × 5 in. bottomless pots during October inside greenhouses. We start with disinfected pots, filling them with potting soil containing 65 percent bark, 20 percent Canadian peat, and 15 percent sand (6B gravel). To each cubic yard of soil, 10 pounds of Osmocote 18-6-12, 1½ pounds of Micromax, and 10 pounds of lime are added.

The trays are then placed on racks approximately 12 in. above the floor of the greenhouse. This distance above the floor enables good air root pruning. It is my belief that root pruning is one of the factors that gives us accelerated growth. It results in the development of a root system that is superior to root systems formed in conventional pots with bottoms.

When the seeds are ready or made available they are sown directly into the bottomless pots. The number of seeds planted in each pot is determined through past experience and success and, of course, depends upon the cultivar. After seed germination the seedlings are thinned to one per pot, leaving the largest seedling possible. The liners are grown in an unheated greenhouse through the winter and into the spring. We wait until the liners have grown to approximately 12 to 15 in. tall and have filled the bottomless container with enough roots that we can shift them up easily without loss of soil and without shock. The shift-up timing is crucial. If we can move up our seedlings by the first two weeks of June, we can grow a salable tree 5 to 6 ft. tall by fall. Unfortunately, this kind of growth does not occur with all cultivars.

Timing is not the only crucial factor when shifting up liners. Soil mix is also vital to successful transfer. When we shift our liners to 4-gal. pots, the soil mix used is exactly the same as the soil used to produce the liners. Soil compatibility ensures a smooth transition. In addition, we prefer to dibble a tablespoon of Osmocote 18-6-12 under the liner. This ensures that fertilizer is available when and where the plant needs it.

It is extremely difficult to determine which factor gives the greatest accelerated growth. We do feel, however, that the greatest improvement in growth has been due to the use of the bottomless pots, resulting in the development of a well-branched, fibrous root system.

TREE PRODUCTION FROM CUTTINGS

At Simpson Nurseries the majority of our softwood cutting production takes place in 2¼ × 2¼ × 3-in. rose pots with bottoms. Although some of our production from cuttings is taking place in bottomless pots, it is only a small percentage at this time. Most of our softwood cuttings are taken between the end of May and the

middle of August. Our propagation mix consists of 50 percent bark, 25 percent perlite, 15 percent Canadian peat, and 10 percent sand (6B gravel). To each cubic yard of this soil we add 5 pounds Osmocote 18-6-12, and 1 pound Micromax. After rooting has taken place and top growth is visible, we move certain cultivars of the liners up to 4-gal. containers. However, some cultivars, which will be discussed later, are held in the propagation area through the first winter.

Proper timing is essential when moving the first group of liners up to larger containers. First, the pot should be filled with roots but not to the point of spiraling. Second, only those liners that are ready by the first week of September are shifted up. This precise timing ensures good growth of the top and of the root system by fall so that natural hardening off can occur. For the liners we were able to shift in early July, we dibble a tablespoon of Osmocote 18-6-12 under the liner. Again, timing is crucial. If the liner is dibbled under too late in the summer, natural hardening off will not occur in the fall, increasing our chance of loss due to freezing that winter.

Basically, the growth of the softwood-propagated tree depends on timing. A small percent of the liners potted during the summer will reach full salable maturity by fall. The balance will be ready the following year. As mentioned earlier, some cultivars of liners, particularly red dogwood, *Cornus florida* 'Rubra,' and Bradford pear, *Pyrus calleryana* 'Bradford,' are not moved up the first year. These liners are held in the propagation area throughout the first winter to provide protection from hard freezes. We overwinter our dogwood liners in a greenhouse where supplemental heat and light are provided. Heat is supplied when the temperature is likely to drop below freezing in the greenhouse. Supplemental light is provided to extend the light hours each day until December 25. When the last killing freeze is over, these liners are transferred to 2- or 4-gal. containers, depending on the cultivar. As the liners are shifted up, 1 tablespoon of Osmocote 18-6-12 is dibbled under each one. Again, this helps to ensure optimum growth of the trees.

CONCLUSION

It is extremely difficult to compare the method of growing trees from cuttings with growing trees from seedlings. The time schedules are different, and the reasons for growing different cultivars using either of the two methods vary greatly. However, it is possible to achieve accelerated growth by using each of the methods if the following procedures are incorporated into the propagation process: 1) Use a propagation container that will allow a good fibrous, well-branched root system; and 2) pay close attention to shifting the liner up when the root system has just filled the pot. These two conditions are extremely important in the timely production of quality trees.